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CHARACTERIZING AND MITIGATING PATHOGENIC ORGANISMS RELATED TO CAFOS

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LTG 3 Poster 07

Science Questions

MYP Science Questions

- What BMP treatment systems and restoration technologies are most effective options for watershed management? mixed land use watersheds? reducing habitat alteration? reducing priority stressors?

Research Questions

- What contaminants are released from CAFO manures and how can these releases be minimized?
- What is the fate of pathogenic microorganisms emanating from CAFO operations?
- What treatment and management practices are effective for controlling the release of pathogenic organisms into the environment?

How Research Addresses the Water Quality MYP Goals

The USEPA's 1998 National Water Quality Inventory indicated that agricultural operations, including animal feeding operations, were the most common polluters of rivers and streams, contributing to the impairment of 59% of those surveyed. As a result, the identification of several management practices effective for land conservation and improving water quality in agricultural watersheds became an important goal for EPA. The performance of the various agricultural management practices recommended by the USDA for nutrient and sediment control have not been characterized in terms of controlling microbial contamination of receiving water bodies. Information regarding the movement and survival of manure pathogens in these systems and the environment necessary to make recommendations for controlling their release from agricultural operations are not available.

Long term goal 3 will be addressed by providing some of the tools needed to identify the scope of the risks present and to assess the effectiveness of manure management practices in controlling the movement of microorganisms. Data on pathogen populations in applied animal manure residuals, agricultural runoff, and tile drainage waters from the various projects will be used to evaluate the effectiveness of specific BMPs and manure management systems for mitigating microbial contamination of water bodies. Ultimately, there will be a suite of tools designed to evaluate the numbers and kinds of pathogenic organisms released into the environment from animal waste. Methods will be developed to identify specific pathogens and their sources in watersheds. Multiple types of management practices must be examined in different parts of the US to build the knowledge base needed.

This work is in the first year. New watersheds and management practices will be added as work progresses. Collaboration will be sought with USDA and other Agencies.

Research Objectives

The research in this program has three primary objectives:

- Evaluate methods for detection and enumeration of pathogenic microorganisms and their sources in the environment.
- Identify the scope of environmental degradation posed by the movement of pathogenic microorganisms from animal feeding operations, and
- Evaluate several management practices used at various animal feeding operations for controlling the release of pathogenic microorganisms into the environment. Practices include vegetated buffer strips, lagoons, constructed wetlands, and terraces.

Research Methodology & Collaboration

Methodology:

- Idexx defined substrate technology for quantification of fecal bacterial indicators in treatment systems and runoff waters.
- High-throughput microbial dilution plates and PCR techniques used to characterize the microbial communities with respect to resistance to a suite of 26 antimicrobials and virulence.
- Cultivation-based and real-time qPCR techniques used to detect and quantify bacterial pathogens including *E. coli* O157:H7, *Salmonella* sp., and *Campylobacter* sp. in treatment systems and runoff waters.
- PCR techniques used to detect source-specific molecular biomarkers in agricultural and mixed-use watersheds.

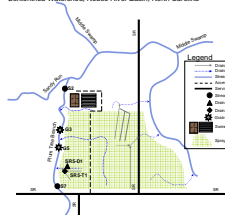
Projects and Collaboration:

- BMP-specific studies at representative CAFOs/AFOs in North Carolina and Iowa to characterize various examples of manure and runoff management practices for the reduction of fecal indicator bacteria, antimicrobial-resistant bacteria, and specific bacterial pathogens.
Collaborators: USGS, Iowa State University
Start date: July, 2005
End-date: Summer, 2007
- Runoff and Biosolids following animal manure and biosolids applications to crop fields in Ohio.
Collaborators: University of Toledo, Bowling Green State University, Medical University of Ohio, USEPA Biosolids Group
Start date: February, 2006
End-date: Fall, 2007
- Survey of agricultural watersheds for pathogenic microorganisms within the USDA-ARS CEAP Watershed program (Iowa, Ohio, and Texas).
Collaborators: USDA-ARS
Start date: Spring, 2006
End-date: Fall, 2007
- Regional Applied Research Effort (RARE) - Cooperative effort with EPA Region 5 to improve winter manure application guidelines.
Collaborators: USDA-ARS, USEPA Region 5
Start date: December, 2005
End-date: Fall, 2006
- Environmental Technology Verification (ETV) - Dairy operation in Wisconsin with anaerobic digestion
Collaborators: Pending
Start date: Pending
End-date: Pending

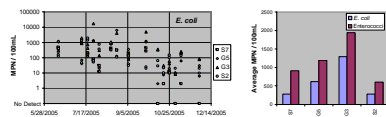
Preliminary Results

Lizzie Swine Production Facility

Continues Watershed, Neuse River Basin, North Carolina



- 5000-head swine production facility
- 1.7 ha facultative waste lagoon and five naturally-ventilated swine houses
- Lagoon wastes are spray-applied to adjacent crop fields
- Overland runoff from manured fields is through natural riparian buffers
- Manured fields are drained by tiles and grass waterways



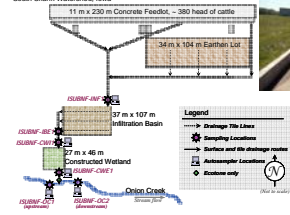
- Lagoon wastes contain on average 150,000 *E. coli* and 200,000 enterococci per 100 mL. *Salmonella* sp. has been detected in the lagoon wastes.
- Fecal indicator bacteria regularly exceed recreational water quality guidelines in the Plum Tree Branch and in the drainage water.
- E. coli* and enterococci in the Plum Tree Branch adjacent to the spray fields are significantly higher than up-stream concentrations ($p=0.05$)
- Down-stream fecal bacterial concentrations are not significantly different than those observed upstream

Research Conclusions & Future Directions

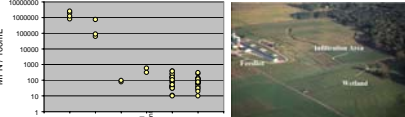
In the near future our plan is to expand our sample collection and analysis work to more feedlot operations and watersheds in different parts of the US. We are making arrangements to cooperate with the USDA-ARS to collect samples from the USDA CEAP research watersheds. The watersheds we are planning to work in are located in Texas, Iowa, and Ohio. Part of the CEAP work is to relate conservation practice implementation with its effectiveness. In most cases, the conservation practices were implemented to address issues other than pathogenic organisms, predominantly sediments and nutrients. We hope to be able to relate conservation practices (BMPs) to microbial populations attributable to CAFOs in the research watersheds. Concurrently with the work in the watersheds, assessment of antimicrobial resistance and genetic analysis methods will be conducted. The methods will be aimed at detection, enumeration, and source identification of pathogenic organisms in waters and complex media such as soil. Correctly identifying the source of microbial input into a watershed will enable focusing of corrective actions more effectively.

ISU Beef Nutrition Farm

South Dakota Watershed, Iowa



- 360-head cattle production facility
- 60-64 pens of 6 cattle each in a single confinement structure
- Liquid runoff from the confinement pens is treated in a vegetative infiltration basin and constructed wetlands
- Solids scraped from the confinement pens are stored and composted on site prior to field application
- Infiltration basin is designed for a 25-year, 24-hour storm event.



- Confinement pad runoff water contains on average 1,600,000 *E. coli* and 161,000 enterococci per 100 mL
- Fecal indicator bacteria usually meet recreational water quality guidelines in Onion Creek, both up-stream and down-stream of the treatment system discharge location.
- Dry conditions have resulted in no discharge from the treatment system.



Interactions with Customers

Our key customers include:

- EPA Office of Water
- Regional Offices
- State Offices

Research results are disseminated to the customers by preparing reports and summary sheets, attending workshops, and publishing in the scientific literature. Progress is being made in integrating technology transfer for public access into research plans at the outset.

Over the last year our research has been presented to the Office of Water, who has the responsibility for writing of regulations and implementation of TMDLs in the US. A series of meetings was held to ensure that we are meeting the needs of the Agency with our planned work and to create paths for dialog with the various offices. We are also working to address the short-term needs of EPA Region 5 to improve manure land-spreading guidance for winter applications before the 2007 planting season begins (Managing Manure Nutrients at CAFOs, Appendix L).

How Research Contributes to Outcomes

Products of this and future projects will make it easier for USEPA Offices and Regional offices to:

- Assess the impact of pathogen releases on watersheds
- Identify sources of microbial pollutants
- Develop and implement TMDLs for pathogen impaired waters

The USEPA Regional offices, USEPA Office of Water, USDA, and others will be able to reference technical guidance in the development and implementation of environmental regulations and recommended manure management practices. Farmers will be able to utilize the recommendations of the USDA and USEPA to select and implement more cost-effective manure management techniques.

As a result the quality of waters now impaired by CAFO releases should improve, aquatic ecosystems will be healthier, and human health risks will be reduced.

